WT 05-212

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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Petition for Waiver of Section 64.402 of the Commission's Rules	)	
	)	

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MAY 1 3 2005

Federal Communications Commission
Office of Secretary

PETITION FOR WAIVER

Pursuant to Sections 1.3 and 1.925 of the Federal Communications Commission's rules, Verizon Wireless requests that the Commission promptly grant a waiver of Section 64.402 of the Commission's rules in order to allow it to implement Wireless Priority Service ("WPS") in the manner agreed to with the Department of Homeland Security.

I. BACKGROUND

On July 13, 2000, the Commission released its Second Report and Order in WT Docket No. 96-86, authorizing Commercial Mobile Radio Services ("CMRS") providers to offer priority access service ("PAS").[1] In that order, the Commission determined "that it is in the public

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[1] The Development of Operational, Technical and Spectrum Requirements for Meeting Federal, State and Local Public Safety Agency Communication Requirements Through the Year 2010; Establishment of Rules and Requirements for Priority Access Service, *Second Report and Order,* WT Docket No. 96-86, FCC 00-242, 15 FCC Rcd 16720 (2000) ("PAS Order"). Priority access service provided by wireless carriers is now commonly referred to as wireless priority service.

interest to permit CMRS systems to provide PAS."[2] Under the terms of the PAS Order and the rules adopted therein, CMRS providers that elect to offer WPS are required to do so in accordance with the policies and procedures set forth in Appendix B to Part 64 of the FCC's rules.[3]

Verizon Wireless has been working with the National Communications System ("NCS"), part of the Department of Homeland Security ("DHS"), and its service integrator, Computer Science Corporation ("CSC"), to develop a CDMA WPS capability, and the parties have now agreed on a WPS capability that will meet DHS' needs for providing priority access to National Security and Emergency Preparedness ("NSEP") users. The network equipment and software currently used to provide CDMA wireless services, however, are not capable at this time of delivering WPS with one of the features required under the FCC's rules, the feature requiring service providers to distinguish among users in different priority groups.[4] Due to the complexity of the software development needed to provide WPS on CDMA networks and the budgetary constraints that exist, the NCS, CSC, the equipment vendors and Verizon Wireless have therefore agreed that CDMA WPS deployment should occur in two phases. In Phase I, all call attempts by priority users will be placed in the same queue awaiting the next available WPS channel, thus different priority levels will not be recognized. All of the other FCC-mandated

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2 *Id.*, at 16728 (para. 15).

3 *See* 47 C.F.R. § 64.402 and Part 64, Appendix B.

4 These features generally include: (1) providing priority access to the next available radio channel to designated priority users during times of emergency; (2) recognize five different user priority levels; (3) providing the ability to access the service by dialing a feature code; and (4) insuring that a reasonable amount of CMRS spectrum remains available at all times for public use. *See* 47 C.F.R. Appendix B.

WPS requirements will be provided in the Phase I capability. In Phase II, priority levels will be recognized in accordance with 47 C.F.R. Appendix B. Work is currently underway to deploy Phase II WPS with the target deployment date being early 2007.

II. REQUEST FOR WAIVER

Section 64.402 of the Commission's Rules states that CMRS providers that elect to provide WPS "shall provide [WPS] in accordance with the policies and procedures set forth in Appendix B to this part."[5] Appendix B provides for five different priority levels to be assigned to NSEP leadership positions.[6] Because the Phase I CDMA WPS capability will not be able to distinguish among users assigned different priority levels, Verizon Wireless must obtain a waiver of Section 64.402 to provide Phase I service. The Commission should keep in mind that the specific requirements in Appendix B, such as the distinct priority levels, were adopted directly from the NCS' proposal for WPS rules. Given that NCS wants to procure WPS from Verizon Wireless without the priority level feature that it itself had asked be included in the rule, the Commission should find that a waiver is warranted.

Verizon Wireless requests that the Commission grant Verizon Wireless a waiver of Section 64.402 of the Commission's rules so that it can provide Phase I CDMA WPS. The waiver requested would take effect upon implementation of the Phase I CDMA capability and remain in effect until Phase II service, which will recognize the five priority levels, is implemented by Verizon Wireless.

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5 47 C.F.R. § 64.402.

6 47 C.F.R. Part 64, Appendix B, Section 5.

The waiver should extend to Verizon Wireless the same liability protection set forth in paragraphs 22-24 of the PAS Order. The same reasons the Commission cited in granting liability protection to WPS providers in the PAS Order are equally applicable to Phase I CDMA WPS. Specifically, the Commission should state that "providing Phase I CDMA WPS to authorized National Security and Emergency Preparedness ("NSEP") users pursuant to contract with CSC, another service integrator under contract to the NCS or DHS, or otherwise approved by the NCS or DHS will be *prima facie* lawful under the Communications Act and will not constitute unreasonable discrimination or an unreasonable act or practice."

III. LEGAL ANALYSIS

Section 1.925 of the Commission's rules requires that entities requesting a waiver demonstrate (1) that the underlying purpose of the rule would not be served or would be frustrated by application to the instant case; and (2) that a grant of the waiver would be in the public interest. Alternatively, entities may demonstrate that due to unique or unusual factual circumstances, application of the rule would be inequitable, unduly burdensome, or contrary to the public interest. The instant waiver request meets each of these criteria.

A. The underlying purpose of Section 64.402 would not be served by application of the rule in this case.

The underlying purpose of Section 64.402 would not be served by applying the rule in this case. In adopting the PAS Order, the Commission stated that the purpose of the rule was "to help meet the national security and emergency preparedness (NSEP) needs of the Nation." At this time, a WPS capability is only available for carriers deploying GSM technology. Only GSM providers are currently providing WPS to NSEP users. Based on year-end 2004 subscriber data reported by the top five CMRS providers, approximately forty-five percent of the United States wireless subscribers are served by carriers using CDMA technology. Verizon Wireless, the nation's second largest wireless service provider with over 45 million subscribers, uses CDMA technology.

Verizon Wireless is the carrier of choice for many government users. Deployment of WPS over CDMA networks will enable those users to have better access to NSEP users during times of emergency. However, the only solution that enables WPS over CDMA networks at this time cannot distinguish among the five user priority levels. Accordingly, a waiver of the priority level requirement is necessary to deploy a CDMA WPS capability by early 2006. Strict adherence to the priority level requirement will only serve to further delay deployment of a CDMA WPS capability. Given that the waiver will allow the government to deploy a CDMA WPS capability much more quickly and that NCS wants to implement CDMA WPS with the priority level limitation, a waiver is warranted.

B. Granting the waiver would serve the public interest.

WPS service is essential to NSEP users during times of emergency when wireless networks can become congested. In the PAS Order, the FCC found that federal, state and local public safety organizations rely on CMRS provider networks in times of emergencies for their CMRS needs. The FCC found, therefore, that "NSEP personnel need the ability to receive priority access when using commercial wireless services during emergencies."[7]

In 2002, the Commission found that a similar waiver request submitted by VoiceStream (now T-Mobile) was in the public interest. In that case, VoiceStream requested a waiver of the WPS requirement that users be able to activate WPS on a per call basis by dialing a feature code. In granting the waiver, the Commission found that the need to make WPS service available to

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7 PAS Order, 15 FCC Rcd at 16725-26 (para. 11).

NSEP users made strict adherence to its rules unduly burdensome and contrary to the public interest.[8] Verizon Wireless believes that a similar finding in warranted in this proceeding.

Recognizing that many NSEP users are Verizon Wireless subscribers, the NCS has made obtaining a WPS capability from Verizon Wireless a priority. Granting the waiver will therefore serve the public interest by enabling Verizon Wireless to provide WPS to NSEP users more quickly, thus improving the ability of NSEP users that are Verizon Wireless subscribers to complete essential wireless calls in a time of emergency.

In order to protect the public interest, the FCC's WPS rules require service providers to "[i]nsure that at all times a reasonable amount of CMRS spectrum is made available for public use."[9] Verizon Wireless has taken great care in designing its potential WPS offering to insure minimal impact on non-emergency callers. Because the waiver only pertains to the respective priority levels of government users, grant of the waiver will not impact the amount of spectrum available for public use.

The WPS software Verizon Wireless will deploy will establish a WPS queue within each cell sector in the Verizon Wireless network to allocate open communication channels to authorized WPS subscribers according to a priority order. No specific channel or block of channels is reserved for WPS use. Instead, the call processing procedures of the Verizon Wireless network will allocate a maximum 25 percent of the radio channels that become available to the queue of WPS subscribers, while maintaining 75 percent of the radio channels

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8 VoiceStream Wireless Corporation Petition for Waiver of Section 64.402 of the Commission's Rules, *Memorandum Opinion and Order,* 17 FCC Rcd 6134, 6140 (para. 17) WT Docket No. 01-333 (2002).

9 47 C.F.R. Part 64, Appendix B, Section 3(e)(8).

for non-NSEP use. By reserving capacity for non-NSEP use, Verizon Wireless will insure that adequate radio capacity is provided to the public during times of increased NSEP calling volumes.

Verizon Wireless will implement this channel reservation scheme by using the "Hard Public Use by Departure Allocation" ("H-PURDA") or an equivalent algorithm within the network-switching infrastructure. The development of H-PURDA and similar algorithms was commissioned and studied by the DHS through CSC.[10] These algorithms have been scientifically proven and confirmed by CSC to VZW to offer the following benefits: (1) queuing for radio resources while also ensuring reasonable capacity for public use calls even when NS/EP calling is excessive; and (2) equivalent overall throughput of non-NSEP calls during congested times when there are NS/EP calls. Indeed, the CSC Algorithm Study demonstrates that during times of emergency when NSEP traffic volumes may spike at one particular location, use of the algorithms studied ensures a relatively high call completion probability for NSEP users while only reducing call completion probability for the general (non-NSEP) public by less than two percent.[11]

By deploying WPS using an algorithm that reserves most network capacity for public use, Verizon Wireless will satisfy the FCC rule requirement to insure adequate CMRS capacity for public use and thereby protect the public interest.

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[10] Wireless Priority Service for National Security/Emergency Preparedness: Algorithms for Public Use Reservation and Network Performance ("CSC Algorithm Study"), prepared by Nyquetek Inc. for DynCorp, August 30, 2002. DynCorp is the predecessor in interest to CSC. The CSC Algorithm Study is attached to this Petition as Appendix A.

[11] CSC Algorithm Study at 17-19.

IV. THE FCC SHOULD ALLOW EX PARTE CONTACTS ON A PERMIT BUT DISCLOSE BASIS

Section 1.1208 of the Commission rules provides that waiver proceedings, such as this, are deemed restricted proceedings for ex parte contacts purposes, meaning that ex parte contacts with the Commission are prohibited if any other entity makes a filing in the proceeding.[12] The Commission, however, has the discretion to modify the normal ex parte rules by order, letter or public notice, where the public interest so requires.[13]

Verizon Wireless respectfully requests that the Commission rule that ex parte contacts be permitted in this proceeding on a permit but disclose basis. In this proceeding, the Commission will be determining the terms by which Verizon Wireless will provide WPS service to the federal government. Permitting ex parte communications (subject to rules requiring that a letter be filed summarizing those communications) will facilitate communication among Verizon Wireless, NCS, CSC and the FCC which will in turn help to expedite action on this request.

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[12] 47 C.F.R. § 1.1208 and Note 1.

[13] 47 C.F.R. § 1.1200(a).

V. CONCLUSION

Verizon Wireless respectfully requests that the FCC grant a waiver of Section 64.402 of the Commission's rules in order to allow it to implement Phase I Wireless Priority Service ("WPS") without the ability to distinguish among the five priority levels required in the FCC's rules. The federal government has requested Phase I WPS from Verizon Wireless without the priority levels initially, in order to meet its need for a CDMA WPS service. As discussed above, adherence to the FCC rule in this case will frustrate the purpose of the rule and granting the waiver will serve the public interest.

Dated: May 13, 2005

Respectfully submitted,

Verizon Wireless

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APPENDIX A

Wireless Priority Service for National Security / Emergency Preparedness: Algorithms for Public Use Reservation and Network Performance

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Version 0.9

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1. Summary

The Wireless Priority Service (WPS) feature set provides National Security / Emergency Preparedness (NS/EP) calls the benefit of queuing for radio and trunk resources while also ensuring reasonable capacity for Public Use calls. The feature set has the following additional benefits when compared to wireless performance without the feature set:

- Improves Public Use performance (and overall throughput, i.e., carrier resource utilization) during both normal times and congested times when there are no NS/EP calls

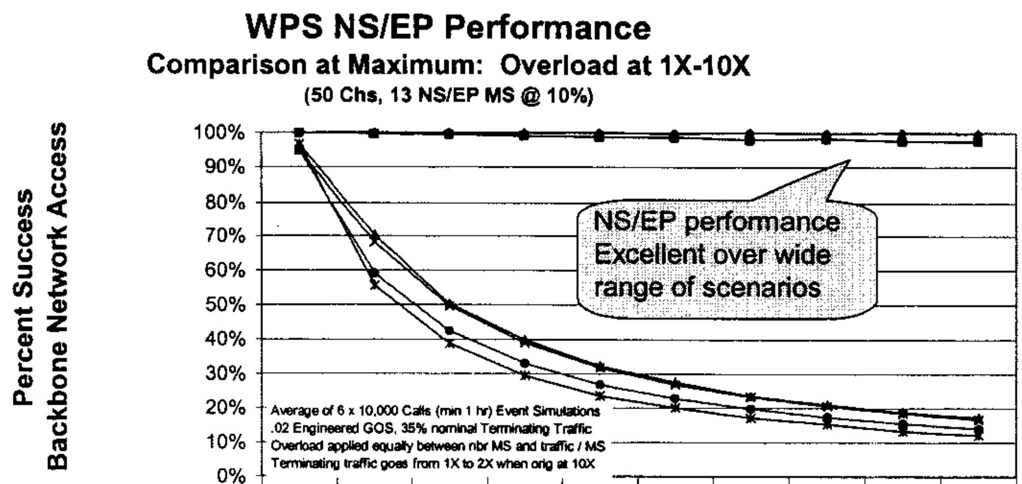
- Improves overall throughput during congested times when there are NS/EP calls

- Improves Public Use performance during congested times if NS/EP calling become excessive (NS/EP benefit suffers when NS/EP calling becomes excessive)

- If NS/EP calling is excessive and there is no Public Use calling, throughput will remain high and WPS priorities will be applied to assure the highest priority calls are successful, although the overall WPS benefit will be greatly reduced

Over the broad operating range where the feature set delivers its best improvement for NS/EP call access to radio resources (i.e., from 2X to 9X overloads with NS/EP calls at a volume of up to 10% of a cell's nominal engineered capacity), the feature set has minimal impact on Public Use performance, generally causing about a 2% reduction in Public Use network access success when at the greatest level of NS/EP calling volume. Over a more conventional range of overload (e.g., 1X to 2X where 1.3X is Mothers' Day) the feature set provides a net improvement to both NS/EP and Public Use calls.

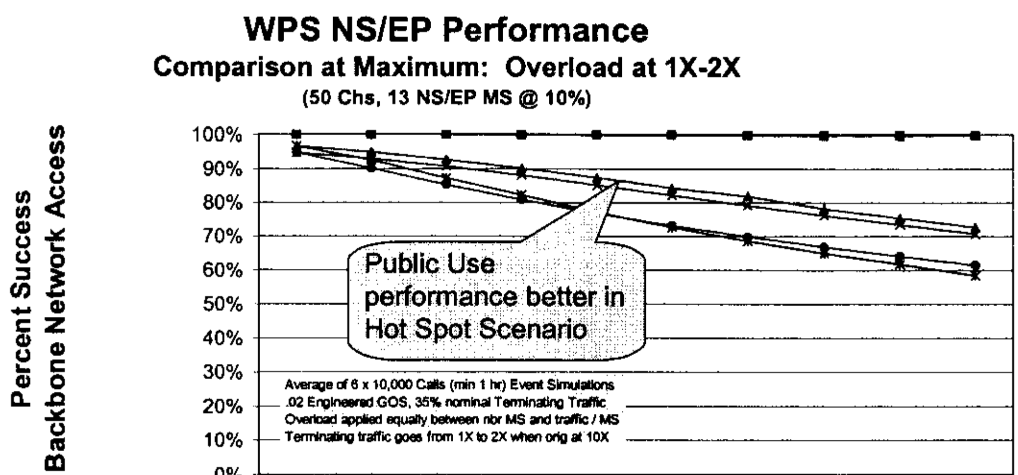
The feature set is based on queuing all calls for access to radio traffic channel resources, with NS/EP calls having a higher priority, a larger queue capacity, and a longer maximum time allowed in queue than Public Use calls, and with only NS/EP calls allowed to queue for access to trunk resources. The overall benefit of the feature set is portrayed in Figure 1-1 for NS/EP calls at their expected maximum and the overload range of normal engineered load (1X) to worst case overload (10X), and in Figure 1-2 for the more conventional overload range of 1X to 2X. The benefit of the feature set is expressed in most general terms as the improved likelihood of NS/EP calls accessing the Public Switched Telephone Network (backbone). The PSTN already provides NS/EP calls priority treatments through the Government Emergency Telecommunications Service (GETS) for a high end-to-end likelihood of call completions during congestion conditions causing most conventional (i.e., Public Use) calls to be blocked. A "pigeon language" expression of the basic radio access queuing algorithm is given in Figure 1-3.



	1	2	3	4	5	6	7	8	9	10
NS/EP Wide	1.000	1.000	1.000	.999	1.000	.998	1.000	.998	1.000	.997
NS/EP Hot Spot	1.000	.997	.994	.990	.987	.986	.980	.983	.976	.977
Public Hot Spot	.965	.704	.504	.397	.323	.276	.236	.211	.188	.173
Hot Spot Analytical Model	.947	.682	.496	.388	.318	.269	.233	.206	.184	.167
Public Wide	.966	.558	.387	.294	.236	.201	.171	.153	.133	.121
Wide Analytical Model	.947	.591	.424	.330	.270	.228	.198	.174	.156	.141

Overload (X Times Engineered Load)

Figure 1-1: General Benefit Over Broad Range of Congestion Conditions



	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
NS/EP Wide	1.000	1.000	1.000	1.000	1.000	1.000	1.000	.999	1.000	.999
NS/EP Hot Spot	1.000	1.000	1.000	.999	.999	.999	.999	.998	.998	.998
Public Hot Spot	.967	.950	.927	.902	.874	.843	.819	.783	.755	.727
Hot Spot Analytical Model	.947	.930	.907	.881	.851	.821	.791	.762	.734	.707
Public Wide	.966	.926	.872	.822	.771	.726	.686	.650	.618	.584
Wide Analytical Model	.947	.901	.852	.808	.768	.732	.699	.669	.641	.615

Overload (X Times Engineered Load)

Figure 1-2: Public Use and NS/EP Benefit for Conventional Overload Range

ARRIVALS

1. When a New Call arrives: (originating or terminating)
    a. If radio traffic channel resources available then assign to New Call
    b. Else: (insufficient radio resources available for assignment, i.e., "no channel available")
        i. If the New Call is an NS/EP call entitled to priority treatment then
            1. If NS/EP Queue is Not Full then New Call joins the NS/EP Queue with position determined by priority and time (i.e., FIFO by Priority)
            2. Else: (NS/EP Queue is full)
                a. If NS/EP Queue has call of lesser priority then
                    i. New Call displaces call of least priority, latest arrival in NS/EP Queue
                    ii. Displaced call is blocked
                b. Else New Call is blocked
        ii. Else: (the New Call is a Public Use (non-NS/EP) call)
            1. If Public Queue is not full then New Call joins the Public Queue
            2. Else New Call is blocked

DEPARTURES

2. When an established call releases: (originating or
    a. Increment Allocation_Counter
        i. If Allocation_Counter greater than ALLOC_MAX (e.g., 4) set Allocation_Counter to one (i.e., cylical counter)
        ii. If Allocation_Counter less than or equal to NS/EP_ALLOC (e.g., 1) then Set Allocation_Flag to TRUE
        iii. Else set Allocation_Flag to FALSE
    b. If released radio resources enable a new call to be setup then
        i. If Allocation_Flag is true then
            1. If NS/EP Queue is Not Empty then serve NS/EP Queue
            2. Else: (NS/EP Queue is empty)
                a. If Public Queue is Not Empty serve Public Queue
                b. Else (Public Queue also empty) Radio Traffic Channel Resources become available for next arriving call
        ii. Else: (Allocation_Flag is false)
            1. If Public Queue is Not Empty then serve Public Queue
            2. Else: (Public Queue is empty)
                a. If NS/EP Queue is Not Empty serve NS/EP Queue
                b. Else (NS/EP Queue also empty) Radio Traffic Channel becomes available for next arriving call

Figure 1-3: Pigeon Language Version of Queuing Algorithm (PURQ-AC)

Conclusions drawn in the report are:

1. PURQ-AC is the preferred algorithm providing the best balance of NS/EP likelihood of call completion, Public Use protection, and ease of implementation.

2. PURQ-AC performance in terms of delay, utilization, and convergence to allocated call capacity share is acceptable.

3. PURQ-AC coupled with trunk queuing gives a high likelihood of success in accessing the PSTN backbone during Hot Spot scenarios where most of the PSTN access blocking is in the radio access.

4. PURQ-AC combined with trunk queuing gives a high likelihood of NS/EP call success in accessing the PSTN during Wide overload scenarios where most of the blocking is in the trunk groups.

5. Both radio access queuing and trunk queuing are needed to ensure a high end-to-end likelihood of NS/EP call completion over a wide range of congestion scenarios.

6. The highest priority should be assigned to the smallest group of NS/EP users, and progressively lower priorities to larger groups.

7. The larger the maximum number of NS/EP calls allowed in the NS/EP queue the better will be NS/EP blocking performance, but the maximum can be set as low as five with acceptable performance.

8. The larger the maximum number of calls allowed in the Public Use queue the better will be Public Use blocking performance, although a maximum of one call is adequate to ensure reasonable origination capacity is reserved for Public Use and to make Public Use performance better than the nominal (without WPS) Public Use performance.

9. For both NS/EP queues and Public Use queues, blocking performance is better when the maximum allowed number in queue and maximum allowed time in queue is greater; for practical purposes, NS/EP queues can be set with attributes of maximum number equal to 5 and maximum time equal to 28 seconds, and Public Use queues with maximum number equal to 1 and maximum time equal to 5 seconds.

10. NS/EP performance is very sensitive to small cell size and much less sensitive to large cell size; addition of Super Count can mitigate the small cell size sensitivity.

11. The Random Access Control Channel can become congested in large cells at high overloads, and NS/EP users' MSs must be assigned an Access Load Control class

which can be exempt from normal Access Load Control restriction when applied to control congestion.

12. It is important to ensure the additive maximum allowed total number of queued calls (i.e., the sum of the maximums for each queue type) is less than the provisioned number of GSM SDCCH channels.

13. Directed Retry considerably improves Public Use performance during Hot Spot scenarios, with minimal impact on NS/EP performance; GSM systems must account for Directed Retry use of SDCCH to ensure adequate provisioning for WPS.

14. Handover priority treatment does increase Handover success and has little affect on NS/EP performance, but does have a small, but statistically significant, negative affect on other Public Use performance.

15. NS/EP performance is insensitive to traffic routing mix (although a change in mix can vary the blocking sources of Public Use calls).

16. Emergency 911 calls can be given priority queuing at a lower priority than NS/EP calls with significant improvement in the 911 call likelihood of access to a radio traffic channel with minimal impact on NS/EP performance, but does place additional demands on SDCCH provisioning in GSM systems.

1.1 Purpose

The purpose of this paper is to document the results of performance modeling to date of the NS/EP Wireless Priority Service (WPS).

1.2 Scope

The scope of this paper includes both originating and terminating wireless calls and their access to and from the PSTN. The scope does not include priority treatment within the PSTN except for NS/EP calls leaving the PSTN for termination on a wireless switch; such calls are assumed queued by the PSTN switch as part of GETS.

The scope includes the major modeling assumptions and discussion of results from a number of event simulation experiments. The scope does not include a detailed discussion of the simulation package, although a brief discussion is provided. The scope does not include discussion of corresponding analytical models, although a brief description of some primitive models is provided for comparison purposes.

1.3 Organization of Paper

The paper is organized as follows:

- Section 1: Summary – presents an overview of the results and a description of the purpose, scope, and organization of the paper.

- Section 2: Problem Description – gives a brief description of the need for an NS/EP WPS, the technical challenges in providing such a service, and the major assumptions used in modeling performance of the feature set to be used in providing such a service.

- Section 3: Public Use Reservation Algorithms – describes basic radio traffic channel priority access algorithms considered to date, with comparison of the PURQ-AC algorithm with its evolutionary predecessors.

- Section 4: Network Modeling and Bottlenecks – describes the performance of the feature set as a function of overall network congestion scenarios.

- Section 5: Sensitivities – provides a digest of sensitivity results from examining performance.

- Section 6: Public Use Reservation Event (PURE) Simulation – gives a brief description of the simulation tool used in conducting the experiments.

- Section 7: Conclusion – concludes the paper.

2. Problem Description

During major disasters, either man made such as the 9/11 terrorist attack, or natural such as earthquakes and hurricanes, the Public Switched Telephone Network (PSTN) experiences severe congestion. NS/EP leadership and key staff responding to the situation often need to make PSTN calls during such severe congestion. The problem is to enhance the PSTN so that such calls can be recognized and given priority treatment as needed to ensure a high likelihood of call completion even though most other calls are being blocked.

The Government Emergency Telecommunications Service (GETS) provides priority treatment of NS/EP calls within the landline segments of the PSTN. However, GETS does not address the wireless segments of the PSTN. Prior to 9/11, the National Communications System (NCS), the White House agency of the Federal government responsible for GETS, had been charged to achieve wireless priority access for NS/EP calls. The NCS petitioned the Federal Communications Commission (FCC) for an affirmative rulemaking on a set of consistent operating principles for such a service, including that it be voluntary on the part of Commercial Mobile Radio Service (CMRS) providers. After a prolonged rulemaking period, the NCS petition was granted, but the lack of a conventional business case for such a service precluded industry from its offering.

The events of 9/11 substantially changed the situation in two respects: the Government escalated the urgency for a WPS and allocated the money needed to develop and deploy the required technology, and industry acknowledged the urgency and agreed to work with the Government on an accelerated basis to develop and deploy the technology.

The changed situation has lead to a joint Industry Requirements (IR) specification of software enhancements needed for the wireless call processing infrastructures to recognize and authenticate NS/EP calls and provide them effective priority treatment. The feature set has been focused on allowing recognized NS/EP calls to queue for access to radio traffic channels and landline trunks when they encounter blocking due to all resources being used. GETS has proven that queuing is an effective priority treatment mechanism so long as the priority share of the traffic is relatively small and the resource set is reasonably large. However, the FCC rulemaking required that, in addition to providing NS/EP calls priority treatment, CMRS providers ensure a reasonable capacity was maintained at all times to also serve Public Use calls. This requirement has driven the industry to look at algorithms by which Public Use could be protected during events giving rise to NS/EP calling activity. This paper demonstrates how one set of such algorithms has been investigated by simulation and found to give high likelihoods of NS/EP call completion while having a minimal impact on Public Use.

2.1 Severe Congestion

A network is normally engineered in terms of its blocking Grade Of Service (GOS) for a specified traffic level. In the wireless segments of the PSTN, such GOS engineering is typically a probability of blocking (Pb) for radio traffic channel access equal to two percent (Pb = .020) for the Average Busy Season Busy Hour (ABSBH) traffic. This is also expressed for our purposes as a probability of completion of 98 percent (Pc = .980). For the corresponding cell size, expressed in terms of the engineered number of channels, the ABSBH traffic is considered here to be the nominal engineered load, expressed as 1X.

On Mothers' Day (and other high usage days) the network may experience congestion with overloads of 1.2X to 1.4X. A severe local congestion problem may drive the congestion level in a cell to 1.6X to 2.0X. Networks are designed to sustain their throughputs under such circumstances, but anything over 1X results in a degradation of the GOS, with 2.0X for a 50 channel cell causing the probability of completion to reduce to about 60 percent. For purposes of modeling, it is assumed that the increase in traffic is equally distributed between an increase in the number of users making calls, and the number of calls a user makes, e.g., an overload of 2X is reflected in $\sqrt{2}$ more than normal users making $\sqrt{2}$ more than normal calls ($2X = \sqrt{2} * \sqrt{2}X$)

NS/EP events may experience overloads of up to 10X. Under these circumstances, the GOS deteriorates dramatically, with a 50 channel cell having a 12% probability of completion. The probability of completion approaches the relationship

$$Pc = 1 / \text{Overload}$$

as the overload becomes severe. The challenge for WPS is to achieve a probability of completion for NS/EP calls of better than 90% under such circumstances, and to do so with minimum impact to the Public Use probability of completion.

2.2 NS/EP Leadership and Key Staff Traffic

The estimated number of NS/EP Leadership and Key Staff to be served nationwide by the combination of all WPS providers is approximately 50,000. There are a variety of estimates for such a figure; the one applied here is a combination of the demographic estimate of Emergency Preparedness users given in Table 1 with NCS National Security estimates, and tempered by GETS experience.

The Cellular Telecommunications and Internet Association (CTIA) tracks the wireless industry infrastructure development. CTIA reports that there are now over 100,000 cell sites in the country. This suggests that an average cell would have less than .5 NS/EP users in it at a random time in which a spontaneous NS/EP event occurred (e.g., an earthquake). A more "typical" estimate applied for modeling purposes is an 80/20 estimate in which 80% of the NS/EP users are in 20% of the cells, giving a "typical" situation of approximately 2 NS/EP users per cell.

Emergency Preparedness Category	Total Number	Percent NS/EP Leadership and Key Staff	Number WPS
Firefighters	239,000	1.00%	2,390
Firefighter Volunteers	1,500,000	.25%	3,750
Police Officers	704,000	1.40%	9,856
911 operators (landline)	50,000	.00%	0
EMTS	150,000	.00%	0
Physicians	560,000	.10%	560
Physicians Assistants	64,000	.00%	0
Registered Nurses	1,970,000	.00%	0
Licensed Practial Nurses	699,000	.00%	0
Nures's aides	1,310,000	.00%	0
Ambulance Dirvers	18,000	.00%	0
Water/Waste Personnel	98,000	.10%	98
Electric Power Presonnel	47,000	.10%	47
Rail Transportation Personnel	83,000	.10%	83
Critical Infrastructure Managers	156,000	4.00%	6,240
SubTotal	7,648,000	.30%	23,024
Federal Government			
Civilian	2,800,000	0.20%	5,600
Active Military	1,370,000	0.25%	3,425
Military Reserve	1,370,000	0.05%	685
SubTotal	5,540,000	0.18%	9,710
Total State Government	4,040,000	0.15%	6,060
Total Local Government	10,670,000	0.10%	10,670
GRAND TOTAL			**49,464**

Table 2-1: Emergency Preparedness Demographics and WPS User Estimate

Using the 2 NS/EP users per cell estimate and recognizing that there are now over 100,000,000 wireless subscribers (an average of over 1,000 per cell), the NS/EP user population is conservatively assumed to be typically less than .2% of the user population in a cell at the time of a spontaneous incident.

Not all incidents are spontaneous and most incidents result in attraction to the incident of NS/EP users. Similarly, the "typical" has a distribution and a proper design must account for the tails of such a distribution. For purposes of this paper, the maximum concentration of NS/EP users in a cell that must be effectively accommodated by the feature set is assumed to be .8% of the cell's normally engineered population, or approximately four times the "typical" 80/20 distribution number. If indeed there is an underlying probabilistic distribution of NS/EP users with a probability of .002 (i.e., .2%) likelihood of a random user being an NS/EP user, then the likelihood that in an "average" cell of 1,000 random users the probability of the number of NS/EP users being 8 or less is better than .999 (i.e., 99.9%). Thus the design assumption of a maximum NS/EP population of .8% of the cell's normally engineered population is considered conservative.

Congestion, as noted in Section 2.1, is assumed to be a combination of increase in the number of users and in the call attempts per user. The number of NS/EP users is noted above. The CTIA reports that the average cellular user makes an average .44 calls per hour (assumed here to be the ABSBH hour). However, NS/EP users are expected to be more intense users than average. An independent analysis team jointly lead by the CTIA and Telcordia estimated that the average NS/EP user would produce 5.6 calls per hour. A rationale for such an estimate is given in Table 2-2. This is about 13 times the average (non-NS/EP) user.

NS/EP Users	Calls per Hour	Percent Population	Weighted Calls per Hour
Very Heavy	20	15%	3.0
Heavy	6	25%	1.5
Medium	2	50%	1.0
Light	1	10%	0.1
Total		**100%**	**5.6**

Table 2-2: Rationale for 5.6 Calls per Hour per NS/EP User

Finally, the CTIA reported that the average cellular call holding time is approximately 150 seconds. Government studies of the GETS traffic indicate that NS/EP calls during the 9/11 incident had essentially the same average holding time as other calls, with the same exponential distribution. Thus the 150 second average call holding time was applied to NS/EP calls as well, with an assumed exponential distribution.

2.3 Network Architecture

A cellular network consists of:

- Mobile Sets (MS) – the instruments (mobile phones, handsets) used to make and receive the mobile calls.
- Base Transceiver Station (BTS) – the radios and antennas located at what is commonly referred to as the cell site.
- Base Station Controller (BSC) – the radio resource management assembly used to allocate resources in response to call requests, with one BSC serving multiple BTSs.
- Base Station Subsystem (BSS) – the combination of BSCs and BTSss

- Mobile Switching Center (MSC) – the main call processing and switching system performing the MS authentication, digits analysis and routing of called numbers, switching of call paths, and trunks to outside networks, including SS7 signaling; one MSC typically controls multiple BSCs.

There are various other components in the network, but the above are the essential ones to understand the basics of the approach of using queuing to provide priority treatment for NS/EP calls. These components connect calls to the MSC where they are interconnected to the PSTN Local Exchange Carriers (LECs), Interexchange Carriers (IXCs), the 911 Public Safety Access Points (PSAPs), and other provider and third-party networks. A view of the network as used for modeling is shown in Figure 2-1.

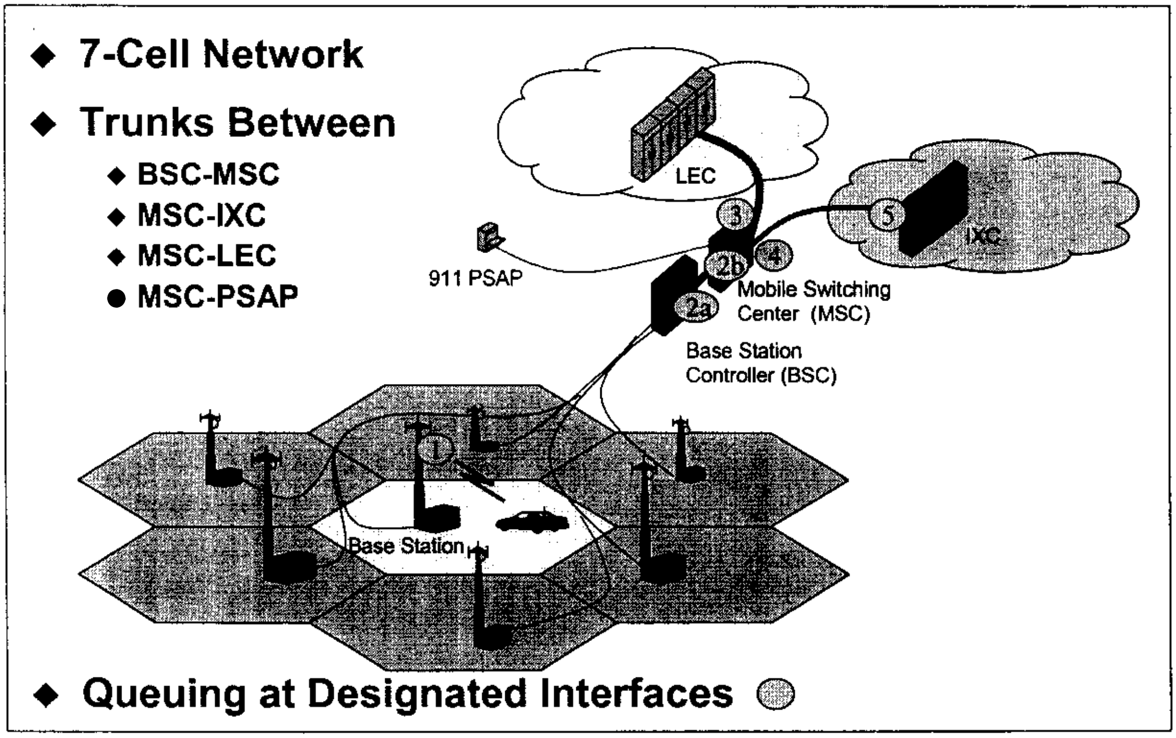


Figure 2-1: Basic Cellular Network Architecture as Used in Modeling

The MS and BTS interconnect to each other via the (radio) air interface. The other components are interconnected to each other via "trunks". The air interface is (generally) provisioned to provide a fixed number of voice-capable traffic channels per cell, as discussed in Section 2.2. The trunk interface from the BTS to the BSC is generally non-blocking. However, the other trunk interfaces are generally concentrated and can be a source of blocking. For modeling purposes, the BSC/MSC interface is assumed to be engineered to a .5% blocking (i.e., Pb = .005), and the MSC to IXC and MSC to LEC interface is assumed to be engineered to a 1% blocking (i.e., Pb = .010). The MSC to PSAP interface is assumed to be engineered to a .5% blocking (i.e., Pb = .005).